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(54) **REFRIGERATORS HAVING INTERNAL CONTENT CAMERAS, AND METHODS OF OPERATING THE SAME**

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CPC **H04N 5/2256** (2013.01); **F25D 29/00** (2013.01); **G06F 16/51** (2019.01); **H04N 5/2252** (2013.01); **H04N 5/247** (2013.01); **H04N 7/18** (2013.01)

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See application file for complete search history.

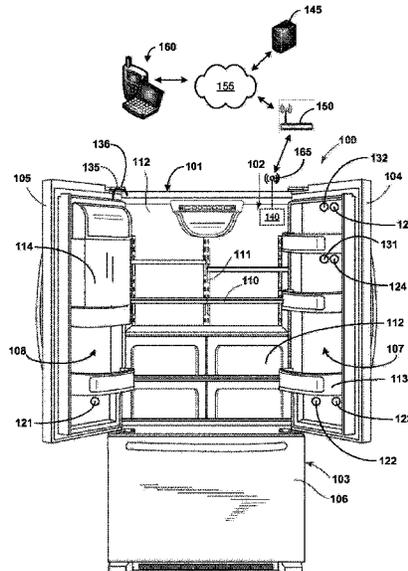
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(57) **ABSTRACT**
Example refrigerators having internal content cameras, and methods of operating the same are disclosed. A disclosed example refrigerator includes a cabinet, an internal compartment disposed within the cabinet, a closing member operatively coupled to the cabinet providing selective access to the internal compartment, two cameras disposed in the compartment and positioned to capture images of different portions of the compartment, two light sources disposed in the compartment, and a controller communicatively coupled with the cameras and light sources and configured to control the light sources to provide two different illuminations for respective ones of the two cameras.

12 Claims, 7 Drawing Sheets



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H04N 7/18 (2006.01)

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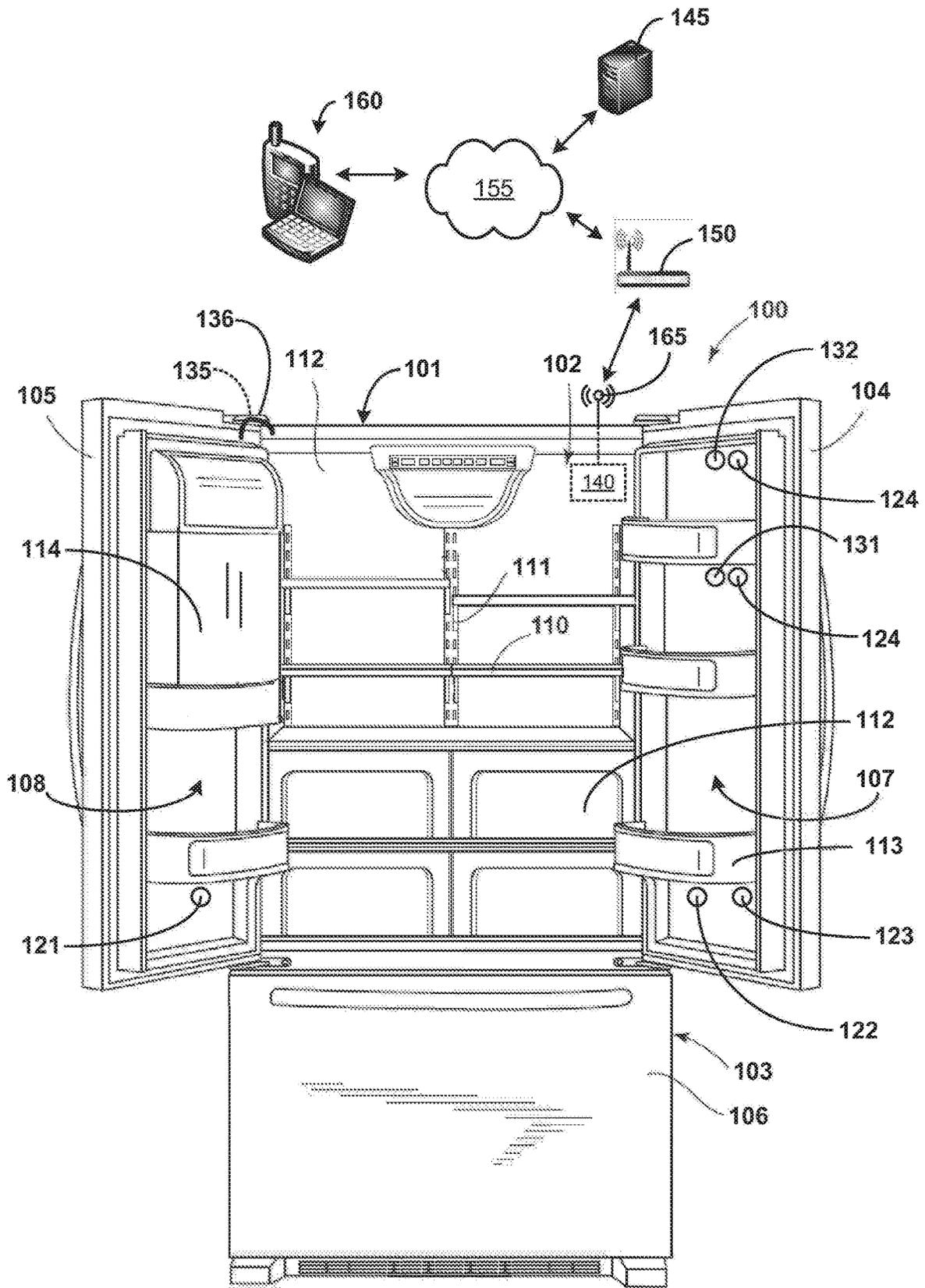


FIG. 1

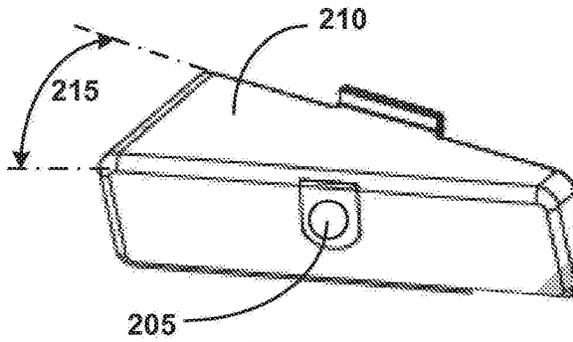


FIG. 2

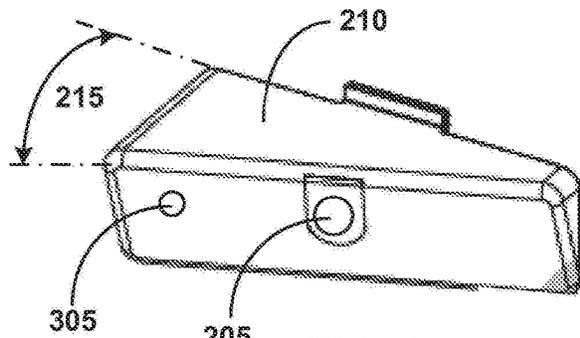


FIG. 3

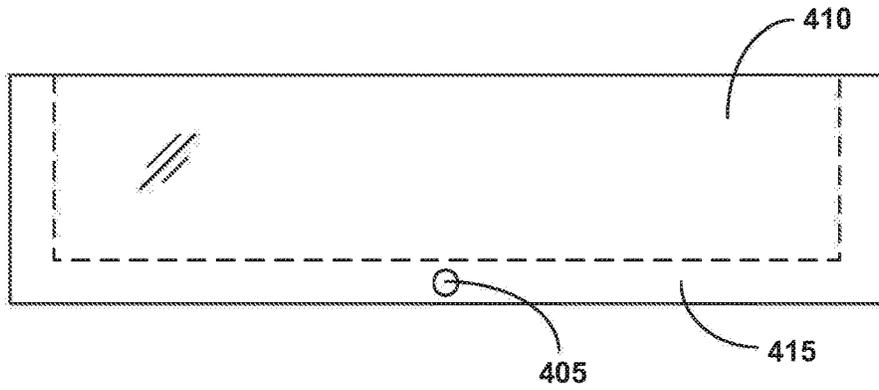


FIG. 4

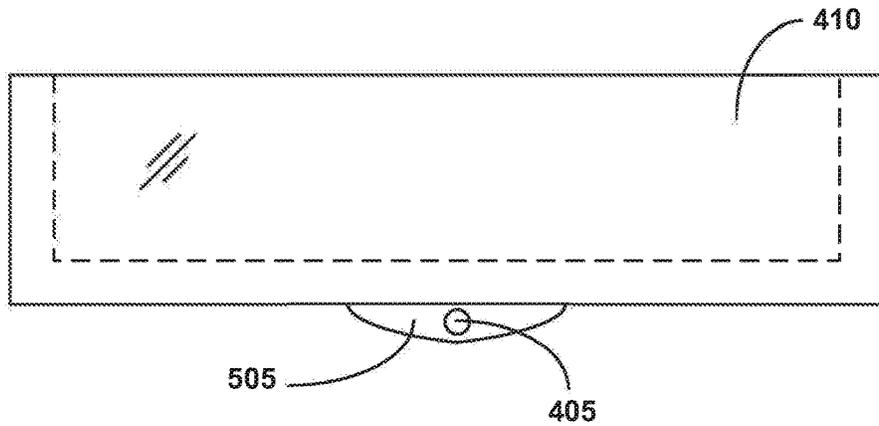


FIG. 5

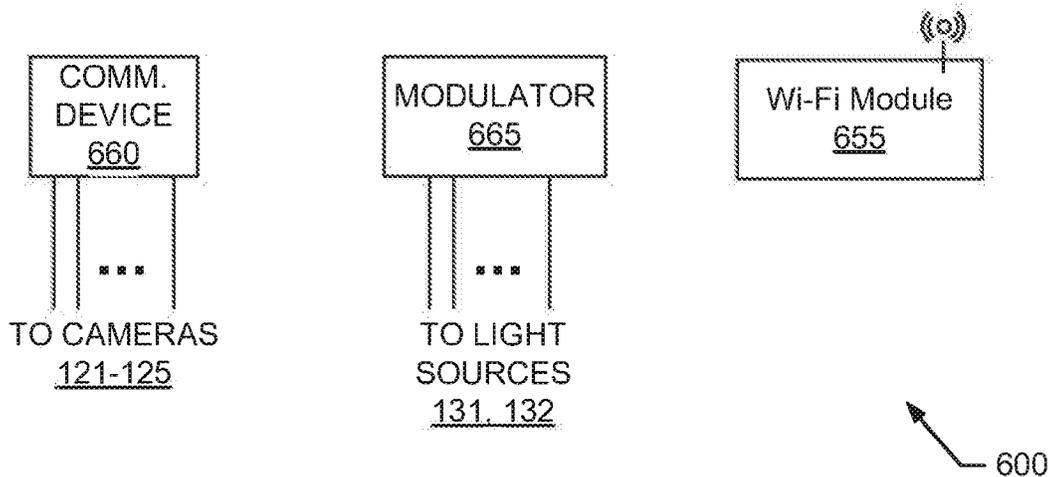
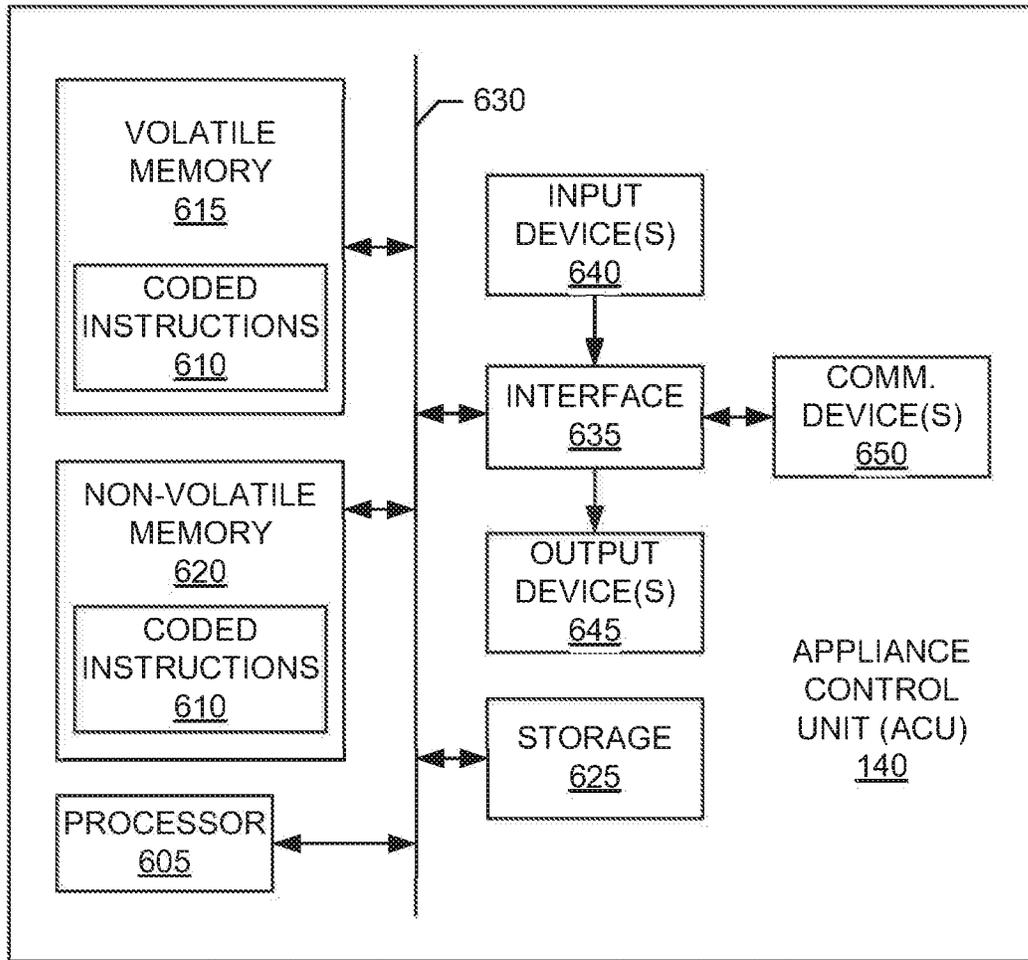


FIG. 6

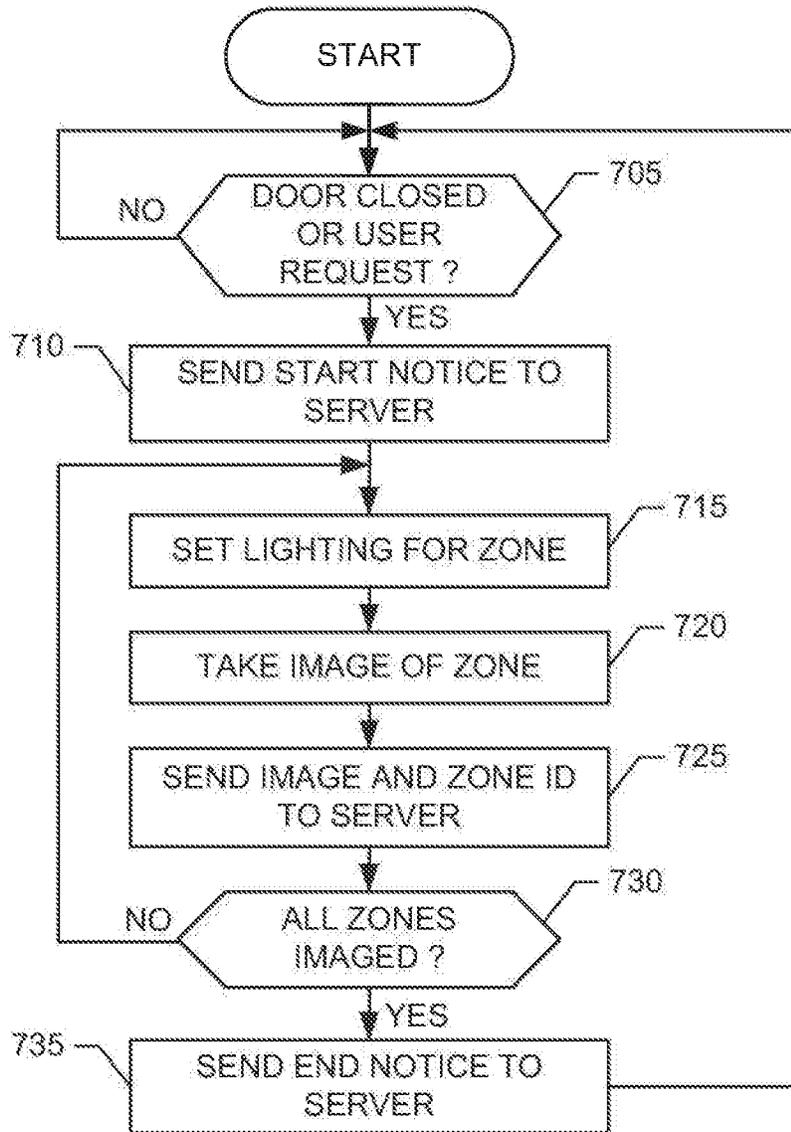


FIG. 7

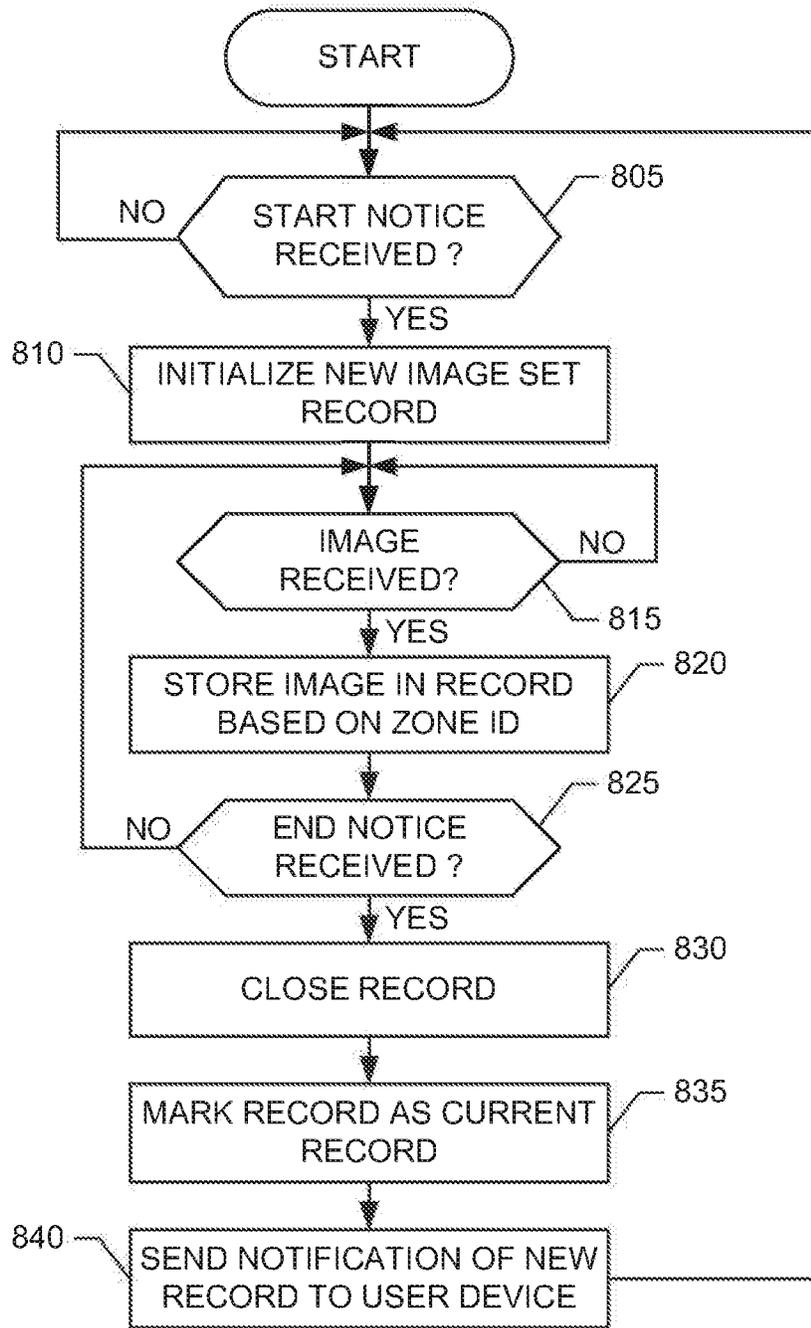


FIG. 8

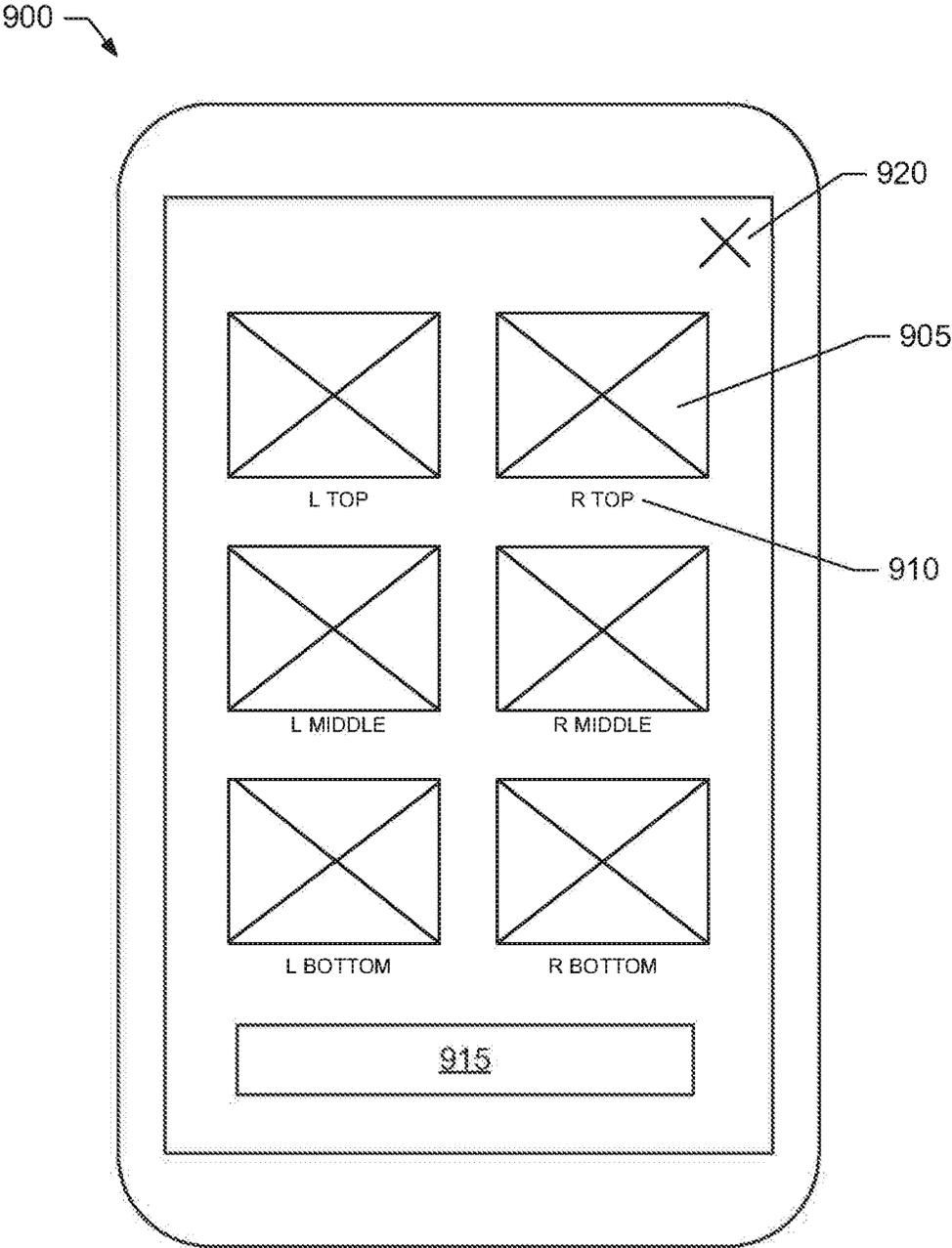


FIG. 9

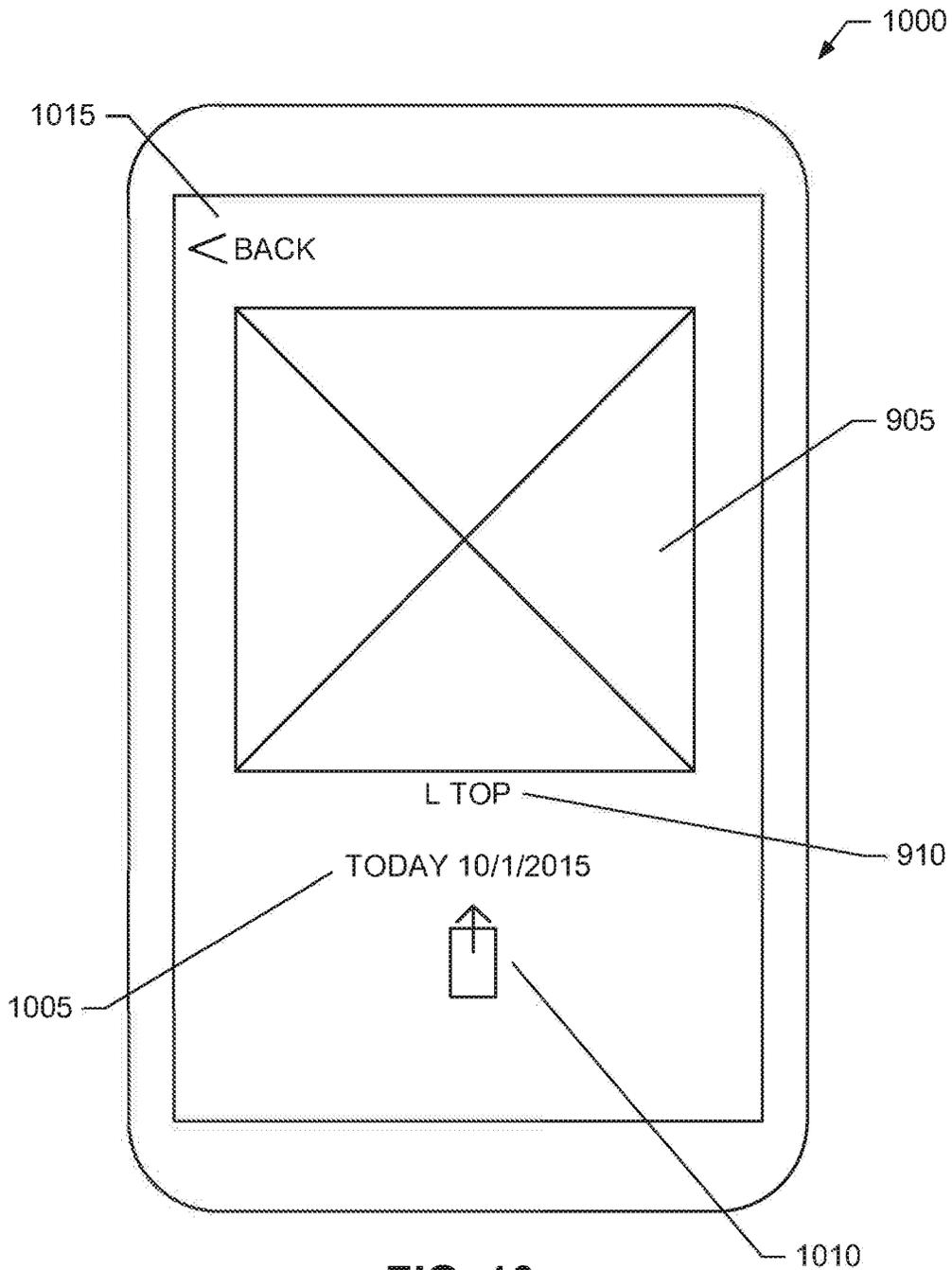


FIG. 10

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REFRIGERATORS HAVING INTERNAL CONTENT CAMERAS, AND METHODS OF OPERATING THE SAME

RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 14/934,316, filed Nov. 6, 2015, now U.S. Pat. No. 10,027,866, and entitled "Refrigerators Having Internal Content Cameras, and Methods of Operating the Same," which claims the priority benefit of U.S. Provisional Patent Application No. 62/201,328, filed Aug. 5, 2015, and entitled "Object Recognition System For An Appliance And Method For Managing Household Inventory Of Consumables," the entirety of both is hereby incorporated by reference.

FIELD OF THE DISCLOSURE

This disclosure relates generally to refrigerators and, more particularly, to refrigerators having internal content cameras, and methods of operating the same.

BACKGROUND

Refrigerators have a cabinet, and one or more internal compartments in the cabinet. Doors are provided to allow a person to selectively open and close the compartment(s). In some examples, when a door is closed, the door prevents a person from seeing at least a portion of the interior of a compartment.

SUMMARY

A disclosed example refrigerator includes a cabinet, an internal compartment disposed within the cabinet, a closing member operatively coupled to the cabinet providing selective access to the internal compartment, two cameras disposed in the compartment and positioned to capture respective images of different portions of the compartment, two light sources disposed in the compartment, and a controller communicatively coupled with the cameras and light sources and configured to control the light sources to provide two different illuminations for respective ones of the two cameras.

A method of operating a refrigerator having two or more cameras, and illumination sources disposed within a compartment of the refrigerator includes controlling the illumination sources to provide a first illumination while one of the cameras captures a first image of the compartment, and controlling the illumination sources to provide a second illumination different than the first illumination while another of the cameras captures a second image of the compartment, wherein the first and second images are of different portions of the compartment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of an example refrigerator having content cameras implemented in accordance with the teachings of this disclosure.

FIGS. 2-5 illustrate example manners of disposing a content camera in the example refrigerator of FIG. 1.

FIG. 6 illustrates an example control platform for the example refrigerator of FIG. 1.

FIG. 7 is a flowchart illustrating an example process that may, for example, be implemented using machine-readable

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instructions executed by one or more processors to implement the example refrigerator of FIG. 1.

FIG. 8 is a flowchart illustrating an example process that may, for example, be implemented using machine-readable instructions executed by one or more processors to implement the example server of FIG. 1.

FIGS. 9 and 10 illustrate example user interfaces that may be implemented by the example user device of FIG. 1 to present images captured of the compartment of the example refrigerator of FIG. 1.

DETAILED DESCRIPTION

In most instances, a person cannot view objects in their refrigerator while the door(s) of refrigerator are closed. This often causes the person to open their refrigerator simply to view the contents of their refrigerator, leading to increased energy consumption. Moreover, a person may not know, but may wish to know, what is in their refrigerator while they are shopping. This can result in running out of staples (e.g., milk, juice, eggs, etc.), or being unable to plan a meal around remaining food items, leading to potential food waste. Current solutions allow a person to view only a portion of their refrigerator; works only when the door is open, and/or requires complex camera movements in order to image larger portions of the refrigerator. In such solutions, crispers, door storage bins, and pantry pans may not be imaged. Content cameras for refrigerators, and methods of operating the same are disclosed herein that overcome at least these problems.

For ease of discussion, the examples disclosed herein are described in the context of a refrigerator. It should be understood that the examples disclosed herein are also applicable to other appliances including, but not limited to, an icemaker, a wine cooler, a freezer, a washing machine, a dryer, a clothes refresher, a stove, a microwave, an oven, and a dishwasher, including configurational variants thereof.

In this specification and the appended claims, the singular forms "a," "an" and "the" do not exclude the plural reference unless the context clearly dictates otherwise. Further, conjunctions such as "and," "or," and "and/or" are inclusive unless the context clearly dictates otherwise. For example, "A and/or B" includes A alone, B alone, and A with B. Further still, connecting lines, or connectors shown in the various figures presented are intended to represent example functional relationships and/or physical or logical couplings between various elements. It should be noted that many alternative and/or additional functional relationships and/or physical or logical couplings may be present in practice. Moreover, no element or coupling is essential to the practice of the examples disclosed herein unless the element or coupling is specifically described as "essential" or "critical".

As used herein, the terms "remote," "remotely," or equivalents or permutations thereof mean that first and second remote functions are implemented by, at, or in separate or different devices, servers, appliances, etc. separated by any distance. Remote does not require a particular minimum separation distance. For examples, functions may be implemented by different devices at the same geographic location (e.g., within a residence or a place of business).

FIG. 1 illustrates an example refrigerator 100 having a cabinet 101, and a refrigerated compartment 102 and a freezer compartment 103 within the cabinet 101. The refrigerated compartment 102 and the freezer compartment 103 each have an open face to provide access to the compartments 102 and 103. The refrigerator 100 includes one or more closing members in the form of doors 104 and 105, and

a drawer **106** moveably mounted to the refrigerator **100** for movement between opened and closed positions to selectively open and close the open faces of the compartments **102** and **103**. The doors **104**, **105** may be formed or made of any combination(s) of glass, metal or any other material(s) that block, partially permit or wholly permit viewing of the compartment **102** while the doors **104**, **105** are closed. The doors **104**, **105** need not be formed of the same material(s).

To allow items to be stored in the refrigerator **100**, the example refrigerator **100** of FIG. **1** includes one or more shelves (one of which is designated at reference numeral **110**). In the example of FIG. **1**, the shelves **110** are supported by brackets (one of which is designated at reference numeral **111**) on a back wall **112** of the compartment **102**. However, other means may be used to support the shelves **110**. The example refrigerator **100** includes any number and/or type(s) of drawers (one of which is designated at reference numeral **112**), and door storage bins (one of which is designated at reference numeral **113**) on the doors **104**, **105** to store items. In the example of FIG. **1**, the refrigerator **100** includes an icemaker and/or ice storage **114** on the door **105**.

While an example refrigerator configuration is shown in FIG. **1**, it should be understood that the content cameras and methods of operating the same disclosed herein may be used with other refrigerator configurations including, but not limited to, a side-by-side configuration, a top-freezer configuration, a 4-door configuration, etc. Moreover, the dimensions and locations of elements shown in FIG. **1** are illustrative, and should not be used to ascertain the actual size and location of those elements in an actual refrigerator. Moreover, the depicted dimensions and locations are not to be used to read dimensions and/or locations, absolute or relative, into the appended claims.

To capture images of the interior of the compartment **102**, the example refrigerator **100** includes five content cameras **121**, **122**, **123**, **124**, **125**. While the example cameras **121-125** are disposed on the doors **104**, **105**, they may additionally and/or alternatively be disposed on the drawer front **106**, or elsewhere within the compartment **102**, and/or within the freezer compartment **103**. Fewer or additional cameras may be implemented. The cameras **121-125** may be disposed at, in, as part of, integral with, etc. liners **107**, **108** of the doors **104**, **105**, as shown in FIG. **1**. When installed, normally during manufacture, the cameras **121-125** become electrically and/or communicatively coupled to other components of the refrigerator **100** using any wired or wireless protocol, signal, component, switch, hub, router, etc. such as, but not limited to, those associated with universal serial bus (USB), wireless fidelity (Wi-Fi®), Bluetooth, RS485, etc., or any combination(s) thereof. Proprietary protocol, signal, component, switch, hub, router, etc. may, additionally and/or alternatively, be used.

To illuminate the compartment **102**, the example refrigerator **100** of FIG. **1** includes one or more light sources, two of which are designated at reference numerals **131** and **132**. In some examples, a light source **131**, **132** is implemented together with each of the cameras **121-125**. Any number of the same or different type(s) of light sources may be implemented. In some examples, the light sources are implemented using light-emitting diodes (LEDs). Additionally and/or alternatively, fluorescent, incandescent, halogen, or any combination(s) of light sources may be used. In some examples, one or more of the light sources are individually, separately and/or differently pulse-width modulated to allow the amount or intensity of light and/or color of light emitted by a light source to be varied and, in some examples, different from another light source. For example, a light

source illuminating a larger area may be controlled to emit more light than another light source associated with a smaller area. In some instances, two light sources may be used to illuminate an area, while only one of them is used to illuminate another area. Further, a light source illuminating the interior of a drawer formed of a color material may be controlled to emit a colored light that at least partially compensates for the color material. Further still, different combinations of light sources **131**, **132** may be used to, for example, reduce shadows. For example, for a shelf **110** where it is typical for a person to place tall items in front of shorter items, light sources **131**, **132** may be positioned and used to light the shelf **110** from different angles with possibly different intensities. Some light sources **131**, **132** may be angled, while others are straight.

During the capture of pictures or images, different colors of light and/or different types of light can be used to create various illuminations. Changes in the color of light such as between blue, green, red and other colors can reveal different characteristics concerning items in the refrigerator **100**. Additionally, different types of light (i.e., fluorescent, incandescent, LED, halogen, combinations thereof, etc.) can have an effect on how an item is imaged. For example, certain types of artificial light may travel through various containers in a more efficient and/or effective manner than other types of artificial lighting. The use of alternate lighting colors and/or lighting types can be helpful to distinguish between items that may have a similar shape. The use of types of colors of light can also assist in determining the state, such as in terms of spoilage, remaining contents, and other information of items.

Additionally and/or alternatively, as shown in FIGS. **2** and **3**, a camera **205** may be mounted in, on, within, etc. a housing **210** that affixes to, mounts to, snaps onto, etc. the liners **107**, **108** of the doors **104**, **105**. A housing **210** may, additionally or alternatively, be disposed on the drawer front **106**, or elsewhere within the compartment **102**, and/or within the freezer compartment **103**. As shown in FIGS. **2** and **3**, the housing **210** may be constructed to position the camera **205** at an angle **215** relative to the liners **107**, **108** of the doors **104**, **105**; and be mounted to the liners **107**, **108** via, for example, a snap feature **220**, a screw feature, etc. As shown in FIG. **3**, a light source **305** may additionally be implemented together with the camera **205** and the housing **210**. When the housing **210** is installed within the refrigerator **100**, the camera **205** becomes electrically and/or communicatively coupled to other components of a refrigerator. In some examples, the camera **205** is manually coupled via a connector, is electromagnetically coupled when proximate to a conductor, connector, pad, antenna, wire, etc. within a door, is wirelessly coupled via Wi-Fi or Bluetooth, etc. In some examples, only some of the cameras **121-125** are angled.

Additionally and/or alternatively, as shown in FIGS. **4** and **5**, a camera **405** may be implemented together with a storage bin **410** that is fixed in place or is selectively positionable. The example storage bin **410** may be used to implement any of the example bins **113** of FIG. **1**. In the example of FIG. **4**, the camera **405** is disposed within a bottom **415** of the bin **410**. In the example of FIG. **5**, the camera **405** is disposed in a feature **505** that extends below the bin **410**. Similar to FIG. **3**, the storage bins **410** may additionally and/or alternatively implement a light source **505**. In some examples, the camera **405** is manually coupled via a connector, is electromagnetically coupled when is proximate to a connec-

tor, wire, cable, pad, emitter, antenna and/or conductor within a door, is wirelessly coupled via Wi-Fi or Bluetooth, etc.

While content cameras implemented on a liner will typically be installed during manufacture of a refrigerator, use of the housings **210** and/or the bins **410** permit content cameras and/or light sources to be installed during delivery or installation, and/or thereafter.

Although cameras and light sources may be co-located, the light sources need not be co-located with cameras. Moreover, there need not be the same number of light sources as cameras. Further, even if cameras are disposed on the doors, one or more of the light sources need not be disposed on a door.

Typically, the content cameras and light sources disclosed herein will be at least partially sealed and/or enclosed to prevent damage due to exposure to, for example, anticipated liquid and/or to facilitate cleaning of the refrigerator. However, content cameras and light sources need not be sealed.

In some examples, a camera and/or a light source disposed on a door is coupled to other components of a refrigerator via one or more wires, cables, conductors, etc. **135** passing through a door hinge **136**. Note, the conductor **135** is purposefully exaggerated in FIG. **1** to assist the viewer. In some examples, multiple cameras and/or light sources are disposed on a door, and are coupled through a top door hinge to, for example, a hub, multiplexer, switch, etc. such as, but not limited to, a USB hub or switch, located at the top of a refrigerator **100** near the top door hinge. The communication hub, multiplexer, switch, etc. may be disposed at other locations such as, but not limited to, together with a controller in the form of, for example, an appliance control unit (ACU) **140** discussed below in connection with FIG. **6**, at a human-interface (HMI) located on a front of door. An HMI allows a user to control and/or monitor an appliance, such as the refrigerator **100**. Of course other locations may be used.

As shown in FIGS. **1**, **4** and **5**, placement of cameras and/or light sources at or beneath a structure, such as a bin or shelf, provides some protection against mechanical damage and/or inadvertent exposure to, for example, liquid. However, cameras and/or light sources may be placed at any suitable or selected location in a refrigerator.

Returning to FIG. **1**, by positioning the content cameras **121-125** on the doors **104**, **105**, images can be captured by the content cameras **121-125** that represent a larger extent of the compartment **102** than existing solutions because of the additional physical separation between the liners **107**, **108** and the front edge of the shelves **110** and the front of the drawers **112**. By being further away from contents of the refrigerator **100**, the cameras **121-125** can capture images having wider fields of view. By purposefully distributing the cameras **121-125** between the doors **104**, **105**, as conceptually shown in FIG. **1**, the cameras **121-125** can collectively image substantially the entire compartment **102**. Furthermore, the conventional structure(s) and/or placement of, for example, storage bins, etc. on the doors **104**, **105** present less impairments to the field-of-views of the cameras **121-125**, as compared to other placements elsewhere within the compartment **102**. In those other placements, shelves, drawers, etc. present greater impairments to camera field-of-view. In some examples, the positions and/or angles of the cameras **121-125** can be determined using, for example, simulation, computer added design (CAD), empirical analysis, etc. In a specific example, one camera is disposed on the door **105** and four cameras are disposed on the door **104** and image a top shelf, a middle shelf, a left crisp drawer, and a right

crisper drawer. Servos, motors, steppers, actuators, linear actuators, etc. may be used to move the cameras **121-125** in one or more directions during use. Use of camera movement may allow the implementation of fewer cameras **121-125**. For example, the ACU **140** can move a camera **121-125** to a first position, capture an image, move the camera to a second position, and capture another image. In this way, the ACU **140** can capture images within the compartment **102** using fewer cameras. Additionally and/or alternatively, a user of the user device **160** can remotely move a camera **121-125** to allow an image to be captured of a particular portion of the compartment **102**.

To control, among other things, the cameras **121-125** and the light sources **131**, **132**, the example refrigerator **100** of FIG. **1** includes the ACU **140**. The example ACU **140** of FIG. **1** controls the cameras **121-125** to sequentially take or capture images or pictures of respective different portions of the compartment **102**. In some examples, at least some of the cameras **121-125** capture images or pictures at substantially the same time. In some examples, the ACU **140** controls the cameras **121-125** to capture the images after the ACU **140** determines that the doors **104**, **105** closed. The example ACU **140** sends the images to a remote server **145** via, for example, a home router **150**, and one or more private and/or public networks **155**, such as the Internet, a cellular network and/or a Wi-Fi network. The images captured by the content cameras **121-125** are provided to or made available to a user device **160**, such as a smartphone or laptop, by the example server **145**. Other example consumer user devices **160** include, but are not limited to, a personal computer (PC), a workstation, a residential gateway, a set-top box, a netbook, a tablet PC, a smart watch, a tablet, a media player, a game console, a Chromebook, and/or any other type of computing device containing a processor. In some examples, a user interface on a front of the refrigerator **100** may implement the user device **160**. In some examples, more than one controller is provided. For example, the controller **140** may detect the closing of the door(s) **104** and/or **105**, while another controller controls a sequence of illumination, and picture or image capture. The other controller may be, for example, the communication hub, multiplexer, switch, etc. discussed above. Other combination(s) of other controllers may be used.

It is contemplated that any number and/or type(s) of wired and/or wireless communication device(s), network(s), technology(-ies), method(s), etc. may be used to communicatively couple the refrigerator **100**, the server **145**, the network **155**, and the consumer user device **160**. Thus, the example shown in FIG. **1** is intended to merely represent example logical couplings between the various elements. Moreover, it should be understood that the example content cameras and methods of operating the same may be implemented using any of these various implementations. Further, while an antenna **165** of the refrigerator **100** is shown as external, it may be partially or fully internal depending on implementation.

In the example of FIG. **1**, the ACU **140** sends images to the server **145** as each image is captured. That is, the ACU **140** waits to capture an image until transmission of a previous image has been initiated or completed. The ACU **140** notifies the server **145** of a first in a sequence of images, and then notifies the server **145** when all the images in a group have been sent. The group reflecting, in aggregate or collectively, a representation of substantially all of the compartment **102**. Other methods of transmitting images may be used. For example, a group of images or pictures can be captured and stored in the refrigerator **10** (e.g., in the

ACU 140), and then subsequently or later transmitted to the server 145 sequentially or in bulk. FIG. 6 discussed below depict example manners of implementing the example ACU 140 of FIG. 1.

When a new group of pictures has been received at the server 145, the example server 145 of FIG. 1 sends a notification to the user device 160 that a new group of pictures is available. Depending on the user device 160, a user of the user device 160 may be notified of the new group of pictures. Alternatively, the user interacts with the user device 160 to determine if/when a new group of pictures is available. Further still, the user may operate a program executing on the user device 160 to check for the group of pictures. In some examples, such a program is a web browser, or a custom-built program provided by the manufacturer of the refrigerator 100, or a designee thereof. The custom-built program may additionally allow the user to monitor and/or control other aspects of the refrigerator 100 and/or other appliances associated with that user. In some alternatives, the user device 160 can directly interact with the ACU 140 locally and/or remotely to directly obtain the group of pictures.

Turning to FIG. 6, an example control platform 600 for the example refrigerator 100 of FIG. 1 is shown. The example control platform 600 of the instant example includes the ACU 140 having at least one programmable processor 605. For example, the processor 605 can be implemented by one or more Atmel®, Intel®, AMD®, and/or ARM® microprocessors. Of course, other processors from other processor families and/or manufacturers are also appropriate. The processor 605 executes coded instructions 610 present in main memory of the processor 605 (e.g., within a volatile memory 615 and/or a non-volatile memory 620), or stored on a storage device 625, a removable computer-readable storage medium such as a compact disc (CD), a digital versatile disk (DVD), a FLASH drive, etc.

The processor 605 is in communication with the main memory including the non-volatile memory 620 and the volatile memory 615, and other storage devices via a bus 630. The volatile memory 615 may be implemented by, for example, synchronous dynamic random access memory (SDRAM), dynamic random access memory (DRAM), RAMBUS® dynamic random access memory (RDRAM) and/or any other type of RAM device(s). The non-volatile memory 620 may be implemented by, for example, flash memory(-ies), flash memory device(s) and/or any other desired type of memory device(s). Access to the memory 615 and 620 may be controlled by a memory controller, not shown.

The control platform 600 also includes an interface circuit 635. Any type of interface standard, such as an external memory interface, serial port, general-purpose input/output, as an Ethernet interface, a USB interface, and/or a peripheral component interface (PCI) express interface, etc., may implement the interface circuit 635.

One or more input devices 640 are connected to the interface circuit 635. The input device(s) 640 permit a user to enter data and commands into the processor 605. The input device(s) 640 can be implemented by, for example, a door closure sensor, a keyboard, a mouse, a touch screen, a track-pad, a trackball, a proximity sensor, and/or a voice recognition system.

One or more output devices 645 are also connected to the interface circuit 635. The output devices 645 can be implemented, for example, by display devices (e.g., a display, indicators, light emitting diodes, and/or speakers. The example lighting sources 131, 132 of FIG. 1 may be imple-

mented by the output devices 645. The example cameras 121, 122 of FIG. 1 may be implemented as input devices 640 and output devices 645.

The interface circuit 635 may also include one or more communication device(s) 650 and/or antennae such as a network interface card or module to facilitate exchange of data with other appliances, devices, computers, nodes and/or routers of a network. For example, the interface circuit 635 may implement a Wi-Fi module 655 and/or the example antenna 165 of FIG. 1.

The example control platform 600 includes a communication device 660 implementing any wired and/or wireless protocol, signal, component, switch, hub, router, etc. In some non-limiting examples, the communication device 660 implements a USB hub or switch, as shown in FIG. 6.

To control the illumination generated by the lighting sources 131, 132, the example control platform 600 includes a modulator, such as a pulse-width modulator 665.

The Wi-Fi module 655, the communication device 660, and/or the modulator 665 may be co-located with the ACU 140, or implemented elsewhere in the refrigerator 100. That is, they may be disposed on any number of printed circuit board(s) located at any number of location(s). For example, the modulator 665 may be implemented on the same PCB as the ACU 140, with the communication device 660 and the Wi-Fi module 655 each located on their own PCBs. The ACU 140 communicates with and receives images from the cameras 121-125 via the communication device 660, including in some examples controlling the position(s) of the cameras 121-125. The ACU 140 controls the intensity and/or color of light emitted by the light sources 131, 132 by, for example, controlling PWM signals generated and sent by the modulator 665 to the light sources 131, 132. The Wi-Fi module 655 implements any number and/or type(s) of wireless communication signals including variants of IEEE 802.11, Bluetooth, etc.

While an example implementation of the ACU 140 of FIG. 1 are shown in FIG. 6, one or more of the interfaces, elements and/or devices illustrated in FIG. 6 may be combined, divided, re-arranged, omitted, eliminated and/or implemented in any other way. Further, any of the interfaces, elements and/or devices of FIG. 6 may be implemented by one or more circuit(s), programmable processor(s), fuses, application-specific integrated circuit(s) (ASIC(s)), programmable logic device(s) (PLD(s)), field-programmable logic device(s) (FPLD(s)), and/or field-programmable gate array(s) (FPGA(s)), etc. Further still, the example ACU 140 may include interfaces, elements and/or devices instead of, or in addition to, those illustrated in FIG. 6, and/or may include more than one of any or all of the illustrated interfaces, elements and/or devices.

FIG. 7 is a flowchart of an example process that may, for example, be implemented as machine-readable instructions carried out by one or more processors, such as the example control platform 600 of FIG. 6. The example machine-readable instructions of FIG. 7 begin with the example control platform 600 waiting until the door(s) 104, 105 of the refrigerator 100 are closed (block 705). When the door(s) are closed (block 705), the control platform 600 sends a start notice to the server 145 that a new group of images of the refrigerator 100 are going to be sent (block 710). The control platform 600 sets and/or controls the light source(s) 131, 132 to form a first intensity and/or color of illumination (block 715), and controls one of the cameras 121-125 to capture an image of a first portion or zone of the compartment 102 (block 720). The control platform 600 initiates sending of the image to the server 145 (block 725). If not all images

have been captured (block 730), control returns to block 715 to capture the next image. When all images have been captured (block 730), the control platform 600 sends an end notice to the server 145 to inform the server 145 that all images have been captured and sent (block 735). Control returns to block 705 to wait for another door closure to be detected. The zones may be imaged in any order such as clockwise or row-by-row.

At block 715, the control platform 600 controls the light sources 131, 135 to collectively emit light of different color, different intensity and/or different angle between at least two of the images. The light may be varied by, for example, changing the number of active light sources, which light sources are active, the angle(s) of active light sources, the color(s) of light emitted by the light sources, the intensity(-ies) of light emitted by the light sources, etc.

In the example of FIG. 7, a door closure event triggers the control platform 600 to capture and send a group of images to the server 145. Other triggers may, additionally and/or alternatively, be used. For example, a person may operate a control panel of the refrigerator 100, a person of the user device 160 may operate the user device 160 to request a new group of images. For example, a person who is shopping may want to capture a new group of images, etc.

Other methods of transmitting images may be used. For example, a group of images or pictures can be captured and stored in the refrigerator 100 (e.g., in the ACU 140), and then subsequently or later transmitted to the server 145 sequentially or in bulk.

FIG. 8 is a flowchart of another example process that may, for example, be implemented as machine-readable instructions carried out by one or more processors to implement the example server 145 of FIG. 1. The example machine-readable instructions of FIG. 8 begin with the example server 145 waiting to receive a start notice from the refrigerator 100 (block 805). When a start notice is received (block 805), the server 145 initializes a record or data set for a new group of images (block 810). When an image is received from the refrigerator 100 (block 815), the server 145 stores the received image in the record or data set (block 820). If an end of notice is not received (block 825), control returns to block 815 to wait for another image. If an end of notice is received (block 825), the server 145 closes the record or data set (block 830), and marks the record or data set as the most recent (block 835). The server 145 sends a notice of the new record or data set to the user device 160 (block 840), and control returns to block 805 to wait for another start notice.

FIGS. 9 and 10 illustrate example graphical user interfaces (GUIs) 900 and 1000 that may be implemented or displayed on a user device 160 to enable a user to display or view images captured in the example refrigerator 100 of FIG. 1. The example GUI 900 of FIG. 9 is activated when, for example, a user selects an "interior view" GUI element of another GUI. The example GUI 900 displays an aggregate or composite of a group or set of images, one of which is designated at reference numeral 905. In some examples, when the GUI 900 is activated, the most recent group of images is displayed.

Each of the images 905 corresponds to a different portion of a compartment of the refrigerator 100. Each of the images 905 has a corresponding label or description 910 that, for example, identifies or indicates the portion of the refrigerator 100 associated with the image 905. The images 905 may be arranged in any way, such as logically corresponding to the respective physical locations of the zones in the refrigerator

100. In some examples, a user can modify the arrangement of the images 905 by, for example, dragging the images 905 within the GUI 900.

One or more GUI elements 915 may be used to move between sets or groups of images taken at different times or on different days. In some examples, the elements 915 include a plurality of selectable GUI elements corresponding to different groups of images. In other examples, a user can move between groups of images using a swipe or scroll gesture. A user may close the GUI 900 by selecting a close GUI element 920.

The example GUI 1000 of FIG. 10 may be activated by, for example, pressing or selecting one of the images 905 in the GUI 900 of FIG. 9. The example GUI 1000 of FIG. 10 displays a larger version of the selected image 905 to permit more detailed viewing, and its associated label 910. The GUI 1000 displays day of week, date, time, etc. information 1005 representing when the displayed image 905 was taken.

In some examples, the GUI 1000 includes a GUI element 1010 that allows a user to, for example, save, send or share the displayed image 905. A close GUI element 1015 is provided to enable a user to return to the example GUI 900 of FIG. 9.

Instead of being embodied as machine-readable instructions carried out by one or more processors, some or all of the example methods of FIGS. 7 and 8 may be implemented using any combination(s) of fuses, application-specific integrated circuit(s) (ASIC(s)), programmable logic device(s) (PLD(s)), field-programmable logic device(s) (FPLD(s)), field programmable gate array(s) (FPGA(s)), discrete logic, hardware, firmware, etc. Further, many other methods of implementing the example methods of FIGS. 7 and 8 may be employed. For example, the order of execution may be changed, and/or one or more of the blocks and/or interactions described may be changed, eliminated, sub-divided, or combined. Additionally, any or the entire example methods of FIGS. 7 and 8 may be carried out sequentially and/or carried out in parallel by, for example, separate processing threads, processors, devices, discrete logic, circuits, etc.

As used herein, the term "computer-readable medium" or equivalents thereof is expressly defined to include any type of computer-readable medium, and to expressly exclude propagating signals. Example computer-readable medium include, but are not limited to, a volatile and/or non-volatile memory, a volatile and/or non-volatile memory device, a compact disc (CD), a digital versatile disc (DVD), a read-only memory (ROM), a random-access memory (RAM), a programmable ROM (PROM), an electronically-programmable ROM (EPROM), an electronically-erasable PROM (EEPROM), an optical storage disk, an optical storage device, a magnetic storage disk, a magnetic storage device, a cache, and/or any other storage media in which information is stored for any duration (e.g., for extended time periods, permanently, brief instances, for temporarily buffering, and/or for caching of the information) and that can be accessed by a processor, a computer and/or other machine having a processor, such as the example compute platform 600 of FIG. 6.

Although certain example methods, apparatus and articles of manufacture have been described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the claims of this patent.

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What is claimed is:

1. A refrigerator comprising:

- a cabinet;
- an internal compartment disposed within the cabinet;
- a door operatively coupled to the cabinet by a door hinge and providing selective access to the internal compartment;
- a camera operatively coupled with the door and adjustable to capture images of different portions of the internal compartment;
- light source disposed in the internal compartment and adjustable to different angles to provide different illuminations within the internal compartment; and
- a controller disposed in the cabinet and communicatively coupled with the camera and the light source through the door hinge.

2. The refrigerator of claim 1, wherein the controller is configured to:

- control the light source to provide a first illumination in the cabinet during capture of a first image; and
- control the light source to provide a second illumination different than the first illumination in the cabinet during capture of a second image.

3. The refrigerator of claim 2, wherein the first and second illuminations differ in color.

4. The refrigerator of claim 1, wherein the images are stored at a remote server for retrieval by a remote user device.

5. The refrigerator of claim 1, wherein the camera is disposed on one of a wall of the internal compartment, a shelf, and a storage bin.

6. The refrigerator of claim 1, further comprising:
a pulse-width modulator, wherein the controller controls the pulse-width modulator to control illuminations made by the light source.

7. The refrigerator of claim 1, wherein the controller controls the camera to capture the images after a door closure event is detected.

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8. A refrigerator comprising:

- a cabinet;
- an internal compartment disposed within the cabinet;
- a door operatively coupled to the cabinet by a door hinge and providing selective access to the internal compartment;
- a camera operatively coupled with the door and adjustable between different positions to capture images of different portions of the internal compartment;
- a plurality of light sources disposed in the internal compartment and adjustable to provide different illuminations within the internal compartment;
- a controller disposed in the cabinet and communicatively coupled with the camera and the light sources through the door hinge, the controller configured to capture the images after a door closure event is detected; and
- an appliance control unit disposed in said refrigerator and configured to store the captured images.

9. The refrigerator of claim 8, wherein the controller is configured to:

- control the plurality of light sources to provide a first illumination in the cabinet during capture of a first image; and
- control the plurality of light sources to provide a second illumination different than the first illumination in the cabinet during capture of a second image.

10. The refrigerator of claim 8, wherein the appliance control unit transmits the images to a remote server for retrieval by a remote user device.

11. The refrigerator of claim 8, wherein the camera is disposed on one of a wall of the internal compartment, a shelf, and a storage bin.

12. The refrigerator of claim 8, further comprising:
a pulse-width modulator, wherein the controller controls the pulse-width modulator to control illuminations made by the light source.

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